Explanation of project assignment

March 14, 2021

Dear all,

Based on the questions of last Friday, I looked into some of things that you mention. I think I now clearly understand the background of your questions and I decided to write down some clarifications for your project.

Traditionally, logic is about identifying valid inferences based on syntactic patterns in some language. It started with Aristotelis who introduced syllogistic reasoning. He considered patterns such as: *all A are B*, *all B are C*, therefore *all A are C*. The syllogism are a subset of natural language. Modern logics make use of a more structured artificial language, but the principle of valid inferences based on syntactic patterns, generally, has not changed. For instance: $p, p \rightarrow q$, therefore q. An advantage of modern logics is that it is easy to define a formal model-based semantics, which makes it possible to verify the correctness of inferences.

Natural logics differ from modern logics by using a subset of natural language instead of an artificial formal language. Reasoning with natural logic still focuses on identifying valid inferences based on syntactic patterns. Your question about substitutions probably was related to this, because it is one of the patterns that is used.

A theory about human reasoning from cognitive psychology says that humans reason by constructing mental models of the world based on the provided information. See for instance the work of Johnson-Laird, his book "Mental Models" or some of his papers. Mental models are related to the semantic tableau method. The construction of a semantic tableau using the available information can be seen as construction of mental models. The main difference is that a semantic tableau uses a 'refutation proof'; that is, we add he negation of the desired conclusion. This has advantages w.r.t. computational efficiency and decidability in case of first order logic. If we do not added the negation of a desired conclusion, the conclusion should hold in every open leaf of the tableau tree.

In this project, I am interested in reasoning with a (controlled) subset of natural language by constructing a semantic tableau (mental models). We can start with some simple natural language subset. To give an example:

- John plays football or chess.

- When it is raining, John does not play football.

- It is raining.

So what can we conclude about John.

A more complicated subset that we may consider later, could be the introduction of quantifiers.